O isotopes in underexplored accessory minerals (titanite and apatite). A new tool for crustal evolution?

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Delineating the evolution of the Earth's continental crust and its extraction from the mantle is key to understanding planetary differentiation. Today, plate tectonic processes play a major role in creating and destroying continental crust. A major point of contention concerns how and when the Earth evolved from an Archean system that generated greenstone belts and Tonalite-Trondjhemite-Granodiorite associations (TTGs) to the modern 'plate' Earth. Linking the rock record with Earth's dynamic system to quantify different aspects of Earth evolution has proven difficult. However, recent advances using stable isotopes have provided new insights on magmatic and metamorphic processes.

O isotope analyses in zircon have been extensively used to constrain the nature of the magma source reservoirs and more particularly the input of recycled material in the source or by assimilation. Zircon has been shown to retain O isotope ratios of the magma source unlike other minerals in which O isotopes can be completely reset when affected by metamorphic or metasomatic events (e.g. quartz). O isotope data from single grains of other accessory minerals is limited. Like for zircon, other accessory minerals have the potential to highlight mantle and/or crustal component in their source.

In this contribution, we expand the use of a range of underexplored accessory phases (titanite and apatite) by developing geochemical indicators involving O isotopes and trace element concentrations to fingerprint crustal evolution. These minerals have the advantage over zircon of being present in less evolved magmas and being more responsive to igneous processes and crustal metamorphism. We present new geochemical data on the accessory phases (titanite, apatite, zircon) of various granitoids through geological time: a BADR suite (Guernsey, Channel Island), "modern" sanukitoids (High Ba-Sr suite, Scotland) and their Archean equivalent (Karelian Province sanukitoids). We demonstrate that O isotopes, trace element analysis and detailed petrographic work on these phases gives direct access to the petrogenesis of the host magmas.